Flexible Systems Approach for Cloud Computing Implementation in Business Organizations

Synopsis of research work

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SECTION 1

1. INTRODUCTION

Computing is being conceptualized as a model consisting of services that are commoditized and delivered in a manner just like ancient utilities like water, electricity, gas, and telecom. In such a model, users access services based on their necessities while not relevancy wherever the services are hosted or however they are delivered (Buyya, et.al, 2008). Many computing paradigms have promised to deliver this utility computing vision and these embody cluster computing, grid computing, and more recently cloud computing. At present, it is common to access content across the web independently without regard to the underlying hosting infrastructure. This infrastructure consists of information centers that are monitored and maintained continuously by content suppliers.

Cloud computing is an extension of this paradigm whereby the capabilities of business applications are exposed as refined services that may be accessed over a network. Cloud service suppliers are incentivized by the profits to be created by charging shoppers for accessing these services. Consumers, like enterprises, are attracted by the chance for reducing or eliminating prices related to ‘‘in-house’’ provision of those services. However, since cloud applications could also be crucial to the core business operations of the shoppers, it is essential that the shoppers have guarantees from suppliers on service delivery. Typically, these are provided through Service Level Agreements (SLAs) between the suppliers and shoppers. The emergence of this development ,usually called cloud computing represents a basic modification in the manner information technology (IT) services are developed, deployed, scaled, updated, maintained and procured(Buyya, et.al, 2008).

A cloud infrastructure is the collection of hardware and software that enables the five essential characteristics of cloud computing. The cloud infrastructure can be viewed as containing both a physical layer and an abstraction layer. The physical layer consists of the hardware resources that are necessary to support the cloud services being provided, and typically includes server, storage and network components. The abstraction layer consists of the software deployed across the physical layer, which manifests the essential cloud characteristics. Conceptually the abstraction layer sits above the physical layer (Meel and Grance 2011).

Computing these days reflects a contradiction in today’s times – on one hand, computers continue to become exponentially powerful and also the cost of computing continues to fall speedily, **so** that computing power in itself is currently thought to be largely a commodity (Hackket and Sean, 2008). On the other hand, as computing becomes more pervasive inside the organization, the increasing complexness of managing the total infrastructure of disparate

information architectures and distributed and software system has created computing dearer than ever before to a company (Roherig and Paul,2009).

Cloud computing represents a convergence of two major trends in information technology – (a) IT potency, whereby the ability of contemporary computers is employed efficiency through highly scalable hardware and software resources and (b) business agility, whereby IT may be used as a competitive tool through fast preparation, parallel execution, use of compute-intensive business analytics and mobile interactive applications that respond in real time to user necessities (Marston, li, et.al,2011).

The conception of IT potency additionally embraces the ideas encapsulated in green computing, since not solely are the computing resources used more with efficiency, but further, the computers may be physically placed in geographical areas that have access to low cost electricity whereas their computing power may be accessed long distances away over the web.

However, because the term business agility implies, cloud computing isn't almost cheap computing – it's additionally about businesses having the ability to use computational tools that may be deployed and scaled speedily, at the same time as it reduces the necessity for large direct investments that characterize enterprise IT setups these days.

Many definitions of cloud computing exist. However none appear to emphasize all the factors that are necessary for businesses as they contemplate cloud computing as a part of their IT arsenal. The researcher has taken into consideration the formal definition of cloud computing as proposed by National Institute of Standard And Technology due to the fact that this definition is widely accepted by industry.

1.1. NATIONAL INSTITUTE OF STANDARD AND TECHNOLOGY DEFINITION OF CLOUD COMPUTING

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell and Grance 2011). The NIST definition of cloud computing describes five essential characteristics, three service models and four deployment models.

1.1.1. Essential Characteristics

- **On-demand self service**: Users are able to provision, monitor and manage computing resources as needed without the help of human administrators
- **Broad Network Access:** Computing services are delivered over standard networks and heterogeneous devices
- **Rapid Elasticity:** IT resources are able to scale out and in quickly and on an as needed basis

- **Resource Pooling:** IT resources are shared across multiple applications and tenants in a non-dedicated manner
- **Measured Service:** IT resource utilization is tracked for each application and tenant, typically for billing.

1.1.2. Three Service Models

- **Software as a Service (SaaS)**

The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings.

- **Platform as a Service (PaaS)**

The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications, created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

- **Infrastructure as a Service (IaaS)**

The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

1.1.3. Four Deployment Models

- **Private Clouds**

The term private cloud refers to exclusive use by a single organization, which is typically controlled, managed and hosted in private data centers. The hosting and operation of private clouds may also be outsourced to a third party service provider, but a private cloud remains for the exclusive use of one organization.

- **Public Clouds**

The term public cloud refers to use by multiple organizations (tenants) on a shared basis and hosted and managed by a third party service provider.

- **Community Clouds**

The term community cloud refers to use by a group of related organizations, who wish to make use of a common cloud computing environment. For example, a community might consist of the different branches of the military, all the universities in a given region, or all the suppliers to a large manufacturer.

- **Hybrid Clouds**

The term hybrid cloud refers to a situation, when a single organization adopts both private and public clouds for a single application in order to take benefits of both.

For example, an organization might run the steady-state workload of an application on a private cloud, but when a spike in workload occurs, such as at the end of the financial quarter or during the holiday season, they can burst out to use computing capacity from a public cloud, then return those resources to the public pool when they are no longer needed.

1.2. CLOUD COMPUTING MATURITY MODEL

The establishment of a cloud computing maturity model (CCMM) provides a framework for successful implementation. GTSI Corp., proposed that for smooth transition from existing IT setup to cloud computing environment with the imperative to consolidate, simplify, optimize an firm's IT environment, and to reduce operational costs. It is recommended that a phased approach to the CCMM should be adopted, which consists of five key components:

• Consolidation
• Virtualization
• Automation
• Utility
• Cloud

1.2.1. Consolidation

A firm's migration towards cloud computing begins with the consolidation of server, storage, and network resources, that works to scale back redundancy, decrease wasted space, and increase equipment usage. Consolidation is achieved primarily through virtualization however can even be approached by the employment of denser computing hardware or perhaps high performance computing. By boosting the speed of essential processes and enabling greater flexibility, the

consolidation of information centers and desktops permits companies to do more with fewer resources, an important concern in today's economic environment.

Network and application upgradation is a vital initial step in enabling the transition to a cloud computing setting. A viable alternative to replacing infrastructure components or rewriting essential applications, modernization promotes communication between older systems and newer solutions, all whereas conserving the worth in existing IT systems.

1.2.2. Virtualization

Virtualization forms a solid foundation for all cloud architectures. It enables the abstraction and aggregation of all data center resources, thereby creating a unified resource that can be shared by all application loads. Hardware such as servers, storage devices, and other components are treated as a pool of resources rather than a discrete system, thereby allowing the allocation of resources on demand. By decoupling the physical IT infrastructure from the applications and services being hosted, virtualization allows greater efficiency and flexibility, without any effect on system administration productivity or tools and processes.

Virtualization when extended to every system component, desktop, network, storage, and servers, enables the mobility of applications and data, not only across servers and storage arrays, but also across data centers and networks. Moreover, through consolidation, one of the critical applications of virtualization, companies can regain control of their distributed resources by creating shared pools of standardized resources that enable centralized management, speeding up service provisioning and reducing unplanned down time.

The result is increased use of assets and simplified lifecycle management through the mobility of applications and data. Although many companies turn to virtualization to improve resource usage and decrease both capital and operating costs, the ultimate goal in cloud computing is the use of the abstraction between applications and infrastructure to manage IT as a Service (IaaS) in a true cloud environment.

1.2.3. Automation

Automation optimizes a firm's virtualized IT resources. Through a transformative procedure, the infrastructure is automated, and critical IT processes become more dynamic and greater management is achieved by trustworthy policies. With automation, information centers will consistently take away manual labour needs for run-time operations. Among the various types of automation in practice these days, provisioning automation is probably the simplest identified and most frequently implemented.

Instead of managing underlying infrastructure, companies in pursuit of cloud computing ought to move toward managing service levels based on what is appropriate for the application users. In this regard, automation becomes a necessary component. With centralized IT and self-service for

end users, automation helps companies to disentangle themselves from the burden of repetitive management procedures, all whereas enabling end users to quickly access what they need.

1.2.4. Utility

In addition to automation, both self service and metering, feedback about the cost of the resources allocated is necessary requirements in creating a cloud service. With breakthrough capabilities for end users and companies, self service and metering facilitate not only better IT management but the further extension of the user experience.

In the cloud, there is no intermediary between the user of a resource and the processes for acquiring and allocating resources for critical mission needs and initiatives. Since the user initiates the service requests, IT becomes an on demand service and the costs of operation drop significantly, because costs are incurred only when the service is used and fewer dollars are spent attending to the needs of the infrastructure.

1.2.5. Cloud

Through cloud internetworking, disparate cloud systems can be linked in such a way, so as to accommodate both the unique nature of cloud computing and the running of IT workloads. This internetworking allows the sharing of a range of IT resources and capabilities, including capacity, monitoring, and management, and the movement of application loads between clouds. Moreover, since interconnectivity can occur across data center and company boundaries, it enables unified metering and billing and one-stop self-service provisioning.

With cloud computing, communication increases significantly, as data sharing between previously separate systems is fully enabled – and collaboration within and between g companies grows exponentially. Ultimately, rather than each company operating in isolation, constricted by the boundaries of its own data center, not only can services be shared among groups, but also costs can be shared and lessened.

1.3. KEY ADVANTAGES OF CLOUD COMPUTING

There are many reasons why organisations of all sizes and types are adopting this model of IT. It provides a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software. Ultimately, it can save companies a considerable amount of money.

1.3.1. Removal / Reduction of capital expenditure

Customers can avoid spending large amounts of capital on purchasing and installing their IT infrastructure or applications by moving to the cloud model. Capital expenditure on IT reduces available working capital for other critical operations and business investments.

Cloud computing offers a simple operational expense that is easier to budget for month-by-month, and prevents money being wasted on depreciating assets. Additionally, customers do not need to pay for excess resource capacity in-house to meet fluctuating demand.

1.3.2. Reduced administration costs

IT solutions can be deployed extremely quickly and managed, maintained, patched and upgraded remotely by the service provider. Technical support is provided round the clock by reputable providers like ThinkGrid for no extra charge, reducing the burden on IT staff.

1.3.3. Improved resource utilisation

Combining resources into large clouds reduces costs and maximises utilisation by delivering resources only when they are needed. Businesses needn't worry about over-provisioning for a service whose use does not meet their predictions, or under-provisioning for one that becomes unexpectedly popular. Moving more and more applications, infrastructure, and even support into the cloud can free up precious time, effort and budgets to concentrate on the real job of exploiting technology to improve the mission of the company.

1.3.4. Economies of scale

Cloud computing customers can benefit from the economies of scale enjoyed by providers, who typically use very large-scale data centres operating at much higher efficiency levels, and multi-tenant architecture to share resources between many different customers. This model of IT provision allows them to pass on savings to their customers.

1.3.5. Customised Scalability

Scalability and flexibility are highly valuable advantages offered by cloud computing, allowing customers to react quickly to changing IT needs, adding or subtracting capacity and users as and when required and responding to real rather than projected requirements. Even better, because cloud-computing follows a utility model in which service costs are based on actual consumption, pay as per use. Customers benefit from greater elasticity of resources, without paying a premium for large scale.

1.3.6. Ease of implementation

Without the need to purchase hardware, software licences or implementation services, a company can get its cloud-computing arrangement off the ground in minutes.

1.3.7. Increased Competitiveness

Historically, there has been a huge disparity between the IT resources available to small businesses and to enterprises. Cloud computing has made it possible for smaller companies to compete on an even playing field with much bigger competitors.

'Renting' IT services instead of investing in hardware and software makes them much more affordable, and means that capital can instead be used for other vital projects.

1.3.8. Ubiquitous Access

Cloud-based IT services let company access their applications and data securely from any location via an internet connection. It is easier to collaborate too; with both the application and the data stored in the cloud, multiple users can work together on the same project, share calendars and contacts etc. It has been pointed out that if internet connection fails, user will not be able to access their data.

Section 2

2. COMPLEXITY OF CLOUD COMPUTING IMPLEMENTATION.

There are a number of key challenges faced by companies that want to move towards cloud computing. The operational issues that will provide the guidelines for cloud computing adoption are listed below.

2.1. Security:

With cloud computing, companies are heavily dependent on the service provider for security. Cloud service providers can claim to provide complete security for access, compliance, data segregation, backup, recovery, etc. With so many new players in the market, how company know that they can trust the supplier. Companies need to know about the security policies of the supplier . (Armbrust et al., 2010) (Heiser and Nicolett, 2008) (Grossman, 2009).

2.2. Data Ownership:

What happens to data when it leaves your organization to reside in the cloud? Companies who move to the cloud probably will not completely lose track of their data but they are likely to lose some level of ownership and, in particular, control. It is important to understand who can access the data and for what purpose (Armbrust et al., 2010) (Buyya et al., 2009) (Kaufman, 2009) .

2.3. Lock-in and Interoperability:

Today each service offering provides its own unique way for the cloud to interact with applications, data and clients. It can be very difficult to use multiple vendors and to seamlessly integrate legacy and cloud services. Companies should have a plan to integrate their cloud services or to move to another cloud supplier in the future. (Armbrust , et al., 2010).

2.4. Standard Architecture:

There is no standard open architecture being used for cloud services. Each of the major cloud providers (Amazon Web Services, Salesforce Force, Google App Engine, and Microsoft Azure)

imposes different architectures that are dissimilar to the common architectures currently used for enterprise apps (Buyya et al., 2009). Althought a customer's functional and technical requirements may be satisfied, the lack of standards will compromise the customer's ability to seamless migrate from one service provide to another and may need a complete re-write of their software to do so.

2.5. Enterprise Support and Service Maturity:

Cloud computing services may not provide the levels of reliability, manageability, and support required by large enterprises. Company should investigate whether cloud supplier is mature enough for their requirements. (Li et al., 2009) (Armbrust et al., 2010).

2.6. Loss of Data:

Data stored in the cloud can be replicated across multiple machines and backed up. However, not all cloud services have the same redundancy for disaster recovery. Does the cloud supplier have an appropriate disaster recovery strategy? (Kaufman, 2009)

2.7. Return on Investment:

The expectation is that external cloud computing can reduce costs. However, the cost advantages for large enterprises may not be as clear as for SMEs. Currently, many large enterprises can reap the benefits of significant economies of scale in their own internal IT operations. What is the real cost of the cloud service (Li et al., 2009)?

2.8. Requirement for Online Connectivity:

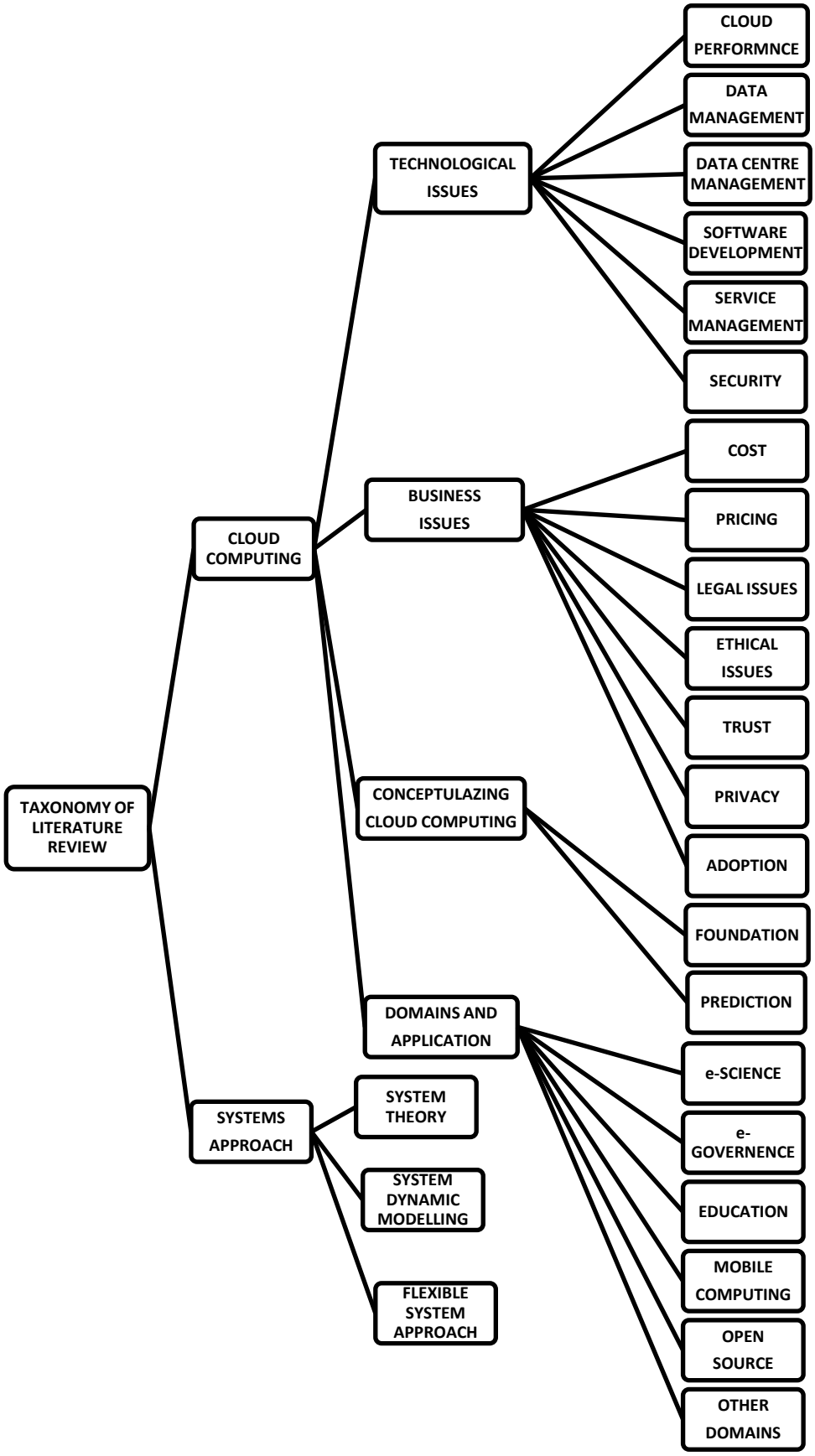
Cloud computing is impossible if you cannot connect to the Internet. A dead Internet connection means it is not possible to work, and in areas where Internet connections are few or inherently unreliable, this could be a problem. What network ambiguity exists between company and the cloud supplier (Armbrust et al., 2010) (Curry, 2004).

In order to overcome these challenges, organizations need a systematic means of reviewing their business needs and weighing up the potential gains and opportunities against the risks, so that the transition to cloud computing is strategically planned and implemented (Conwoy and Curry, 2011).

SECTION 3

LITERATURE REVIEW

In this section, we present a review of the relevant literature in the current area of research. A taxonomical view of the literature review conducted in this synopsis is given in Figure below.


TAXONOMY OF LITERATURE REVIEW
CLOUD COMPUTING
SYSTEMS APPROACH
TECHNOLOGICAL ISSUES
BUSINESS ISSUES
CONCEPTULAZING CLOUD COMPUTING
DOMAINS AND APPLICATION
SYSTEM THEORY
SYSTEM DYNAMIC MODELLING
FLEXIBLE SYSTEM APPROACH
CLOUD PERFORMNCE
DATA MANAGEMENT
DATA CENTRE MANAGEMENT
SOFTWARE DEVELOPMENT
SERVICE MANAGEMENT
SECURITY
COST
PRICING
LEGAL ISSUES
ETHICAL ISSUES
TRUST
PRIVACY
ADOPTION
FOUNDATION
PREDICTION
e-SCIENCE
e-GOVERNENCE
EDUCATION
MOBILE COMPUTING
OPEN SOURCE
OTHER DOMAINS

3. CLOUD COMPUTING

3.1 Technological Issues

This category focuses on technology details of cloud computing. Articles in this category are produced by researchers who see cloud computing as a white-box and are interested in its components and mechanisms. Six categories are related to technological issues.

3.1.1.1. Cloud Performance

This subcategory covers articles focusing on the evaluation and optimization of the performance of the clouds. This includes studies that attempt to quantify and compare performance across different clouds (Iosup et al., 2011), to enhance workflow scheduling and load balancing (Byun, et al., 2011), to improve dynamic resource allocation (Streitberger and Eymann, 2009; Warneke and Kao, 2011), to enable automatic bottleneck detection (Iqbal, et al., 2011), to estimate performance of cloud network with nodes failure (Lin and Chang, 2011), and to improve interoperability across different clouds.

3.1.1.2. Data Management

This subcategory includes specific issues associated with the large scale, distributed data processing in the clouds. This includes data consistency (Vogels, 2009), data redundancy (Pamies–Juarez, et al., 2011), data mining algorithms and methods (Grossman, et al., 2010), integration of distributed data (Chen, et al., 2011), and parallel RDBMS (Relational Database Management Systems) (Stonebraker, et al., 2010).

3.1.1.3. Data Centre Management

This subcategory looks into the foundational enabler of cloud computing, the data centres. Articles in this category concentrate on energy efficiency, power conservation, and environmental considerations in the design of data centres (Beloglazov, et al., 2011; Berl, et al., 2010). In addition, algorithms for energy-aware scheduling are proposed (Mezmaz, et al., 2011).

3.1.1.4. Software Development

This subcategory represents a stream of software developer-oriented research. Articles in this subcategory range from generic discussions on developing distributed and parallel software in cloud computing environments (Lawton, 2008a;Wang,et al., 2010), to specific analyses of particular cloud-based programming frameworks such as MapReduce (Liu, et al., 2011). Novel studies also look into component-based approaches for developing composite applications (Malawski, et al., 2011) and automation in restructuring traditional applications into distributed/partitioned cloud-based ones (Böhm and Kanne, 2011).

3.1.1.5. Service Management

As an emerging research theme focusing on the administration of cloud computing services, this subcategory includes articles exclusively targeting aspects such as service lifecycle in the cloud (Breiter and Behrendt, 2009) and publishing, discovering, and selecting cloud-based services (Goscinski ,et al., 2011).

3.1.1.6. Security

Cloud security has been a common concern for the public (Bellovin, 2011). Some articles in this subcategory look at general security mechanisms such as restrictions and audits (Spring, 2011a; Wang, et al., 2011), multi-tenancy authorization (Calero, et al., 2010), third-party assurance (Zissis and Lekkas, 2010), and cloud-based security services (Li,et al., 2011). Other articles addressing specific cloud related security issues fall into two categories: data security and network security. The data security category includes papers looking at data encryption (Anthes, 2010), data colouring, and software watermarking for multi-way authentications (Hwang and Li, 2010), and a data-partitioning scheme for implicit security (Parakh and Kak, 2009). The network security category includes papers discussing intrusion detection in the cloud (Vieira, et al., 2010), and cloudlevel defence against HTTP-DoS and XML-Dos attacks (Chonka, et al., 2011).

3.1.2. Business Issues

This category concerns the business implications of cloud computing. Articles in this category treat cloud computing as a black-box technology which can generate business value to both providers and users. Seven categories have emerged in this category.

3.1.2.1. Cost

This subcategory examines the economic benefit from a cloud-user perspective. Topics in this category include a comparison between the cost of leasing cloud services and that of purchasing and using a local server cluster (Walker, 2009), techniques to estimate and monitor costs for cloud services (Truong and Dustdar, 2010), algorithms for finding minimum cost storage strategy (Yuan, et al., 2011), and more specific ones such as analysing operational costs for hosting online games in the cloud (Iosup, et al., 2010).

3.1.2.2. Pricing

Articles in this subcategory mainly focus on the pricing strategies of cloud providers. A common approach for studying this topic is to compare different pricing strategies and analyze the pros and cons in terms of acceptance of customers. Comparisons can be made between fixed prices and variable prices (Yeo, et al., 2009), or between piece-rate pricing and flat-rate pricing (Li, 2011).

3.1.2.3. Legal Issues

This subcategory examines legal issues associated with cloud computing. With rapid advancement in technology, regulators are often in a 'catch-up' mode with regard to policy, governance, and law (Kaufman, 2009). Articles in this category introduce general legal risks of adopting cloud computing (Joint, et al., 2009), as well as addressing specific topics such as digital forensic investigation in cloud computing systems (Taylor, et al.,2010) and uncertain jurisdiction for Internet activities in geographically distributed cloud data centres (Ward and Sipior, 2010).

3.1.2.4. Ethical Issues

This subcategory analyses the cloud computing phenomenon from an ethical standpoint. It contains articles which propose that IT professionals, when making decisions about cloud computing deployment, should consider applied ethics methods such as Utilitarian, Deontologist, and Rawlsian (Miller, 2010).

3.1.2.5. Trust

This subcategory examines approaches for cloud providers to gain trust from prospective users. Articles in this category identified two factors affecting trust in the cloud—transparency (Bret, 2009) and public auditability (Wang, et al., 2010). In addition, an instrument for evaluating the transparency of a cloud provider is proposed (Pauley, 2010).

3.1.2.6. Privacy

This subcategory specifically addresses privacy issues from either an ethical or legal point of view. With cloud computing, privacy is an inevitable concern, as the cloud users have to upload and store (in some cases sensitive) business and personal information into remote data centres managed by external parties (Katzan, 2010c). Articles in this subcategory propose a method for analysing privacy in cloud computing in the workplace (Barnhill, 2010) and argue that cloud providers need to display clear policies about how user data is used (Ryan, 2011).

3.1.2.7. Adoption

This subcategory explores topics related to cloud-computing adoption in businesses. Some articles in this category target general businesses by providing ROI (Return on Investment) models for firms to decide on the suitability of adopting cloud computing (Misra and Mondal, 2011). Other articles focus more on SMEs (Small and Medium Sized Enterprises) and look into inhibitors (Truong and Dustdar, 2011) and enablers of the adoption of cloud computing (Yogesh and Navonil, 2010), as well as the benefits of adoption, such as enhanced competitive advantages (Truong, 2010).

3.1.3. Conceptualizing Cloud Computing

This category contains articles that provide a general view of cloud computing practice and research, with an aim to provide a general understanding of this area rather than to focus on any specific facet of it. These articles can be further classified into two subcategories.

3.1.3.1. Foundational/Introductions

This subcategory contains articles that introduce foundational concepts and components of cloud computing. Such introductory articles provide definitions and outline key features of cloud computing (Armbrust, et al., 2010; Mell and Grance, 2010), reflect the timeline of cloud computing (Pallis, 2010), analyse the related benefits and obstacles, strengths and weaknesses of cloud computing and suggest future research directions (Armbrust, et al., 2010; Marston, et al., 2011). To further articulate the essence of the cloud computing paradigm, some articles make comparisons between cloud computing and other concepts such as grid computing (Buyya et al., 2009; Shiers, 2009; Weinhardt, et al., 2009), cluster computing (Buyya, et al., 2009), virtual computing (Cervone, 2010), and even electricity (Brynjolfsson, et al., 2010). Comparisons are also made between public cloud and private cloud (Grossman, 2009), as well as across public cloud providers, such as Amazon, Microsoft, and Google (Buyya, et al., 2009).

3.1.3.2. Predictions

This subcategory contains articles focusing on forecasting the future of cloud computing and suggesting potential implications. Some project the technical and managerial effects of cloud computing on network and software vendors (Cusumano, 2010), as well as on HPC (High Performance Computing) systems (Sterling and Stark, 2009), while others speculate the economic prospects of cloud computing for developing nations (Greengard and Kshetri, 2010; Kshetri, 2010).

3.1.4. Domains and Applications

This category consists of articles which discuss the impact of cloud computing on particular domains or applications. They are further classified into six subcategories.

3.1.4.1. e-Science

This subcategory targets the implications of cloud computing for the e-Science community, which has long been yearning for infinite computing power. e-Science refers to the scientific disciplines (i.e. earth science, bio-informatics, particle physics, etc.) where rapidly increasing volumes of data gathered from sensors and instruments (i.e. the CERN Large Hadron Collider) need to be processed in a timely manner. Cloud computing, with its tremendous computing power and inexpensive cost, has drawn considerable attention from the e-Science community which has traditionally relied on scientific and academic computing grids. Articles in this subcategory aim at understanding the impact of cloud computing on the current computing

infrastructure of e-Science (Armando, 2011). Some look into specific processing of genomic and proteomic data (May, 2010), while others propose generic solutions for managing scientific workflow in the cloud (Yuan et al., 2011).

3.1.4.2. e-Governance

This subcategory discusses the potential of cloud computing for governments. Governments are more hesitant than businesses to adopt cloud computing services. One of the reasons for this is the associated risks and security concerns (Paquette, et al., 2010). However, utilizing cloud computing for electronic voting solutions has been argued to be beneficial and feasible (Zissis and Lekkas, 2011).

3.1.4.3. Education

This subcategory focuses on the impact of cloud computing on educational institutes, especially those in the higher education sector. Operating and maintaining IT infrastructure has cost universities enormous amounts of money; hence, some argue that by adopting cloud-based solutions, such money could be saved and used in places more meaningful to the students and teachers (Ercan, 2010). Articles in this category discuss how a variety of educational areas can benefit from cloud computing, such as those for e learning (Doelitzscher, et al., 2011), online library resources (Jordan, 2011; Robert, 2009), and online collaborative writing (Calvo, et.al, 2011). Some articles analyse more generic issues such as the influence of cloud computing on the job roles of IT staff in higher education (Currie, 2008) and the inevitable adoption of cloud computing driven by NetGens 2.0 students who are born digital natives and rely on cloud-based applications for their life and study (Brown, 2009).

3.1.4.4. Mobile Computing

This subcategory contemplates the potential of combining cloud computing and mobile technologies (Zhang, et al., 2011). Articles in this category have fairly specific focuses, such as implementing a health-monitoring system based on a combination of cloud infrastructure, mobile phones, and sensors (Pandey, et al., 2011) or proposing a ’virtualised screen‘ which is rendered in the cloud and presented on the mobile phone for enabling graphically Volume 31 Article 2 45 rich services on thin clients (Lu, et al., 2011), as well as arguing that migrating computing and storage capability to the cloud not only enhances the power of mobile systems but also extends the battery lifetimes of such systems (Kumar and Lu, 2010).

3.1.4.5. Open Source

This subcategory looks into merging the two paradigms—cloud computing and open source—to build open clouds. The key theme is the proposal that to ensure that the Internet becomes an interoperable ‘network of networks’, cloud platforms should be built on open standards, open interface, and open source software (Nelson, 2009). In addition, some emerging open cloud

platforms are introduced, such as Open Nebula (Milojicic, et al., 2011) and Open Cirrus (Avetisyan, et al., 2010).

3.1.4.6. Other Domains

This subcategory contains articles which each represent a stand-alone topic relevant to the application of cloud computing. Topics include using cloud computing for improving analyzing and reasoning capabilities of semantic search engines (Mika and Tummarello, 2008) for reducing the implementation cost of RFID solutions (Owunwanne and Goel, 2010), for building smaller, cheaper, and smarter robots (Guizzo, 2011), and for developing intelligent urban transportation systems (Li, Chen, and Wang, 2011).

3.2. Systems Approach to Problem Solving

3.2.1. Systems Theory

Systems concepts and methodologies are developed as a response to the ever increasing complexity of the socio-technical and managerial systems. Many techniques and approaches based on system philosophy have been developed which help in analyzing various problem situations in multiple ways (Sushil 1993a). In a seminal paper, Satsangi and Ellis (1971) describe the physical system theoretic construction developed to model the Canadian economy. The authors identify national economy as a collection of interconnected components. The approach taken is that of component-to-system construction. The framework developed is general enough to embrace many "input-output" models in economic literature.

Bertalanfy (1972) has reported extensive developments in the field of General Systems Theory and discussed the trends in System Science, Mathematical Systems Theory, Systems Technology, and Systems Philosophy. General Systems Theory structured sciences and systems and provided answers for a variety of systems such as material systems, informational systems, and conceptual systems (Boulding, 1956). The systems movement has been reviewed by Checkland (1981 a, b). He concludes that the development had been more on the hard systems thinking and recommended that the newer developments should be more on soft systems thinking with a "learning" paradigm. An intriguing review by Troncale (1988) puts the developments in systems sciences together by defining the domains of systems sciences such as General Theory of Systems, Systems Theory, System Analysis, and Systems Applications.

A set of consensus methodologies was suggested by Warfield (1990) while presenting a science of generic design. A subsequent concept of "Total System Intervention" was proposed by Flood and Jackson (1991). Faisal, Banwet and Shankar (2007) discuss the use of ISM approach in information risks management in supply chains. Mohammed, Shankar, and Banwet (2008) discuss the creation of flexible, lean and agile value chain by outsourcing using ISM technique.

3.2.2. System Dynamic Modeling

Forrester (1961) and Sterman (2000) have authored pioneering books in the field of system dynamics. Useful reference texts in this area have been authored by Sushil (1993b) and Mohapatra et al. (1994). Bora et al. (1990) present a system dynamics study to design price stabilization and growth policies in Indian tea industry. Using system dynamics methodology, Jain, Satsangi, and Kothari (1993) examine the effects of urbanization and industrialization on energy-related problems such as high energy demand, air pollution and traffic congestion at urban centres. Impacts of investment in the industrial sector are compared with those due to investment in other sectors and population growth over a period of 20 years. Satsangi et al. (2003) develop a system dynamics simulation model to analyse system behaviour representing city problems in the context of an integrated urban system.

Ge et al. (2004) presents a system dynamics approach for the analysis of the demand amplification problem, also known as the bullwhip effect, which has been studied fairly extensively in the supply chain management literature. The construction of the model is reported using a part of a supermarket chain system in the UK as an example. Sachan et al. (2005) used system dynamics approach to model the Indian grain supply chain involving the dynamic interaction of cost variables that influence the total supply chain cost. The objective is to minimize the total cost of the supply chain.

3.2.3. Flexible Systems Approach

Deriving inspiration from the developments in system methodology in terms of schemes of systems techniques, and a wide applicability of integrated systems in computer based management, Sushil (1993) generalizes the philosophy of integration of techniques over the whole spectrum of system techniques in the framework of Flexible Systems Methodology (Sushil 1993). A specific application of this framework has been recently used in policy and strategy formulation (Saxena et al. 2006). This approach proposes that a flexible policy framework is needed to strategically meet the dynamics of the new era. Flexibility paradigm in this context implies creating more “policy options” in order to have a broader policy choice, thus building “change mechanisms” in policy framework, and providing “freedom of choice” to all the stakeholders (Sushil 2000).

SECTION 4

4. CONCEPTUAL FRAMEWORK

The pattern of company growth over the years is never uniform, particularly once company becomes midsized. Mergers and Acquisition, new product development and market dynamics will propel the pace of Organizational changes which in turn will increase the demand on existing infrastructure to support this rapid growth. Cloud Computing can provide ideal solution

in this scenario with innovative technology accessible in an exceedingly scalable method across a company to meet challenges in infrastructure to support rapid growth.

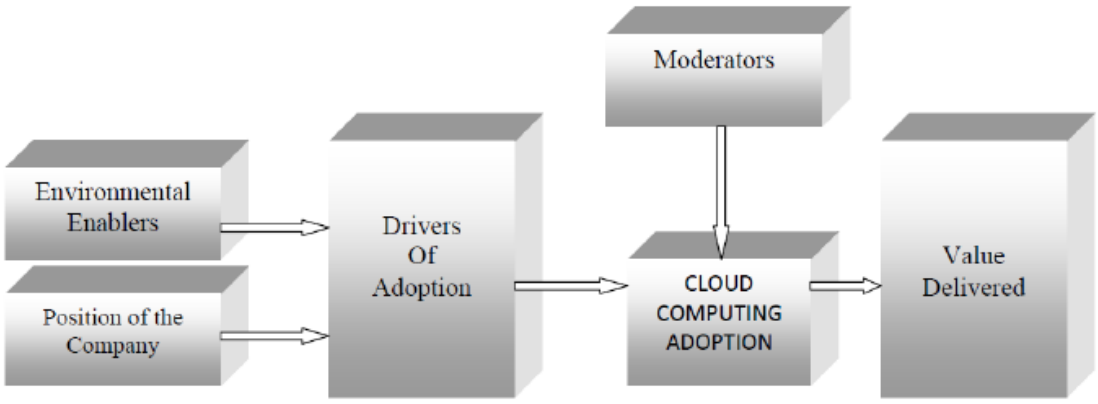
Over the years with different kinds of IT solution being deployed across various department in the company, and also as a result of Mergers and Acquisition, the cumulative portfolio of IT setup in the company is quite varied and non symmetric. Cloud Computing, is the best possible answer to this kind of situation, when cloud deployment provide rationalized and standard solution in sync with company policies to various units in the company customized to their requirement.

One of the key reasons for companies to invest in technology is to increase employee productivity. If the company operations are centralized to a single location only, then coordinating technological demands is far easier in comparison to companies who have multi location presence. According to research a midsize company, on an average have ten locations to cater too, though IT is often based at headquarters. This situation further complicates the issues of providing technology tools in a seamless manner for better productivity of employees. Providing access to advanced networking capabilities via cloud-based solutions will facilitate company providing ubiquitous access to employees. One vital advantage of offerings is that all users run the most recent version of hosted applications, simplifying the support of multiple locations.

From an ROI perspective, the case for any technology investment ought to be based on internal needs, the market resources, external concerns formally examined. The changes competitive setting in addition to the regulative setting will offer robust incentives for adoption of various cloud computing solutions. Cloud solutions may provides opportunities for companies that believes technology as the simplest way to save lots of money , with possibilities of approaching cloud computing as resource of distinctive core competency. Particularly for corporations that may take advantage in off-the shelf solutions enforced in a timely manner, to press for larger business and be more productive. The immediate advantage of cloud solutions are of a tactical nature, providing value in terms of deployment economies. However within the long run, the strategic implications of cloud capabilities are even more valuable, setting the stage for innovative adoption of new technology which will enhance a company's competitive position.

The researcher has proposed a conceptual framework which investigates the factors that contributes towards Cloud Computing adoption in any company. The model also aim to study the impact on the performance of the business, with the adoption of cloud computing. The current position of the company, defined in terms, of its financial health, marketing stature and current stage of technology diffusion and environmental policies. These along with the enablers who can compel company to adapt cloud computing .Enablers are defined in terms of ever changing client preference, competitive setting and government regulatory framework.

The adopters which drive the company towards cloud computing, which include factors like Time to Market, reduced TCO, and Agile Organization etc. All these factors are primarily responsible for adoption cloud computing. The rate of diffusion of cloud computing in any company will further depend on operational flexibility of the task and also the strategic value of that activity. Once implemented cloud computing will be a tool of comparative advantage for companies with advantage such as cost management, resource utilization, process standardization etc.



SECTION 5

5. Systems Approach to Problem Analysis

This section provides a brief overview of the systems approach, which will be used to address the current research problem.

5.1. Introduction

A system is an integrated set of interoperable elements, each with explicitly specified and bounded capabilities, working synergistically to perform value-added processing to enable a user to satisfy mission-oriented operational needs in a prescribed operating environment with a specified outcome. The system has various inputs, which go through certain processes to produce certain outputs, which together, accomplish the overall desired goal for the system. Therefore, as system is usually made up of many smaller systems, or subsystems. For example, an organization is made up of many administrative and management functions, products, services, groups and individuals. If one part of the system is changed, the nature of the overall system is often changed, as well -- by definition then, the system is systemic, meaning relating to, or affecting, the entire system (Sharma and Srivastava 2009). Hall (1969) has given seven phases of systems approach as follows: (i) program planning (ii) project planning (iii) system development (iv) production or construction (v) installation and distribution (vi) operation (vii) retirement.

5.2. Policy Formulation Model and Process

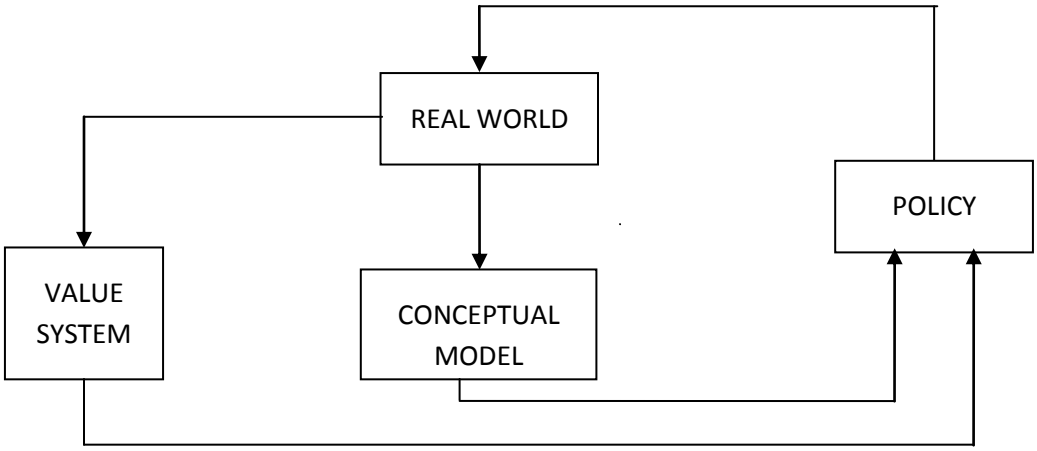
A policy formulation model is as follows. An individual conceives a mental model based on the information from the real world. This conceptual model is used to determine the policy.

Determination of policy is also governed by the value system. Then, the impact of the policy is seen on the real world and again, a mental model is made from the changed world and the cycle continues. This is illustrated in Figure below.

5.3. Need for Systems Approach

Cloud computing is complex and large-scale problem in implementation. Some of these are technological decisions, project management, manpower planning, database management, etc. These problems require large amount of resources and are interdependent. Solution to one problem could be at

Policy Formulation Process



Source: Sage (1977)

the expense of another problem. Thus, we can say that a systems approach would be effective in dealing with these problems. If the decision maker is unable to understand the structure of the underlying system properly, then it will lead to wrong conclusion regarding problem solution. Sage (1977) has considered three levels: symptoms, institutions, and values for application of technology to societal problems. This approach can be used while dealing with management problems by studying them at three levels to determine the solutions.

5.4 An Overview of Tools and Techniques of Systems Approach

5.4.1. Idea Generation

The first step in formulating policies is to generate ideas. Here, a set of people think about the possible ideas related to a particular problem or situation. Then, these ideas are shortlisted and are evaluated in detail. There are various techniques to generate ideas for policy making or problem solving.

5.4.2. Brainstorming

It is a group activity involving experts. They are encouraged to give as many ideas as possible on a particular topic. It focuses on cross-fertilization of ideas given by two or more persons. However, in this method, experts only give ideas rather than evaluating them. The ideas are shortlisted through simple or weighted voting.

5.4.3. Nominal group technique (NGT)

In NGT, participants give their ideas by writing on slips. There is no interaction among them which provides an equal opportunity to everyone to express their views. The ideas are generated independently by the participants, recorded and discussed. Once the list of clear ideas is available, participants vote for the most important ideas to be selected.

5.4.4. Idea writing

This is basically a technique of getting the ideas of the experts written down and collated. Idea writing methodology was propounded by Warfield, but referred to as ‘Brain writing’. Usually, a group of 8-10 participants is formulated. Each participant reacts in writing to the possible policy options and performance indicators. Each participant also reacts to the other participants’ views in writing. The group discusses the principal idea that emerges from the written interactions and summarizes.

5.4.5. Idea Engineering

This is a more formal and structured approach to idea generation which is used with the help of a structured questionnaire. The participants are provided with a structured worksheet with questions and space for writing ideas below each question. All the ideas are then put together to remove duplications and ambiguities. Collated group idea sheets are circulated for voting and the order of priority is decided.

5.4.6. Program Planning

Program planning considers both directly related and indirectly related aspects of the problem. A program is divided into elements which are further sub-divided into related sub-elements under consideration and then we study the interactions among these sub-elements as well as among the elements. Towards this end, a self interaction matrix represents the relationships among the sub-

elements of a particular element. It makes a pair wise comparison and a binary relationship is represented. A cross interaction matrix represents the relationship among the sub-elements of two different elements in the form of binary relationship. All the self interaction matrices, cross interaction matrices and derived matrices put together show the program linkages.

The sub-elements of an element are ranked on the basis of the number of interactions of each sub-element and their percentage share with respect to the total interactions. Based on the value of the total interaction of the sub-element, ranks of all the sub-elements are ascertained to establish the relative importance of each one.

5.4.7. Interpretive Structural Modelling (ISM)

The ISM process transforms unclear, poorly articulated, complex mental models of systems into visible well defined simpler models useful for many purposes. It deals with the interpretation of the embedded object by systematic iterative application of graph theory resulting in a directed graph for the complex system. Each stage of methodology may be viewed as transforming a model from one form to another referred to as model exchange isomorphism. A structural self interaction matrix (SSIM) studies the existence of a relation between any two sub-elements. The experts' responses help in preparing the SSIM. Based on the various matrices data, a graphical depiction ("digraph") is constructed which provides information about hierarchy between the sub-elements in an element. A structural model provides a clearer picture and an understanding of contextual relationships. It is derived from the connected information connected in the digraph.

5.4.8. Indirect Relationships: MICMAC

The MICMAC method is based upon the multiplication properties of matrices. If variable *i* directly influences variable *k* and if variable *k* directly influences variable *j*, any changes affecting variable *i* can have a repercussion on variable *j*. Thus, there is an indirect connection between *i* and *j*. The direct relationship matrix as developed is taken as the base to start the process of finding the ranks of the variables considering the indirect relationships.

5.4.9. Fuzzy Considerations

The notion in the basic set theory is that an item is either a member or not a member of a set.

However, in real life situations, certain sets have imprecise boundaries. A fuzzy set is characterized by a membership function, defined as a real number in the interval (0,1). Fuzzy considerations are incorporated in the techniques of systems analysis as well. In addition to the consideration of interaction between elements and sub-elements (binary relationships), it also considers various levels of the possibilities of interaction.

5.4.10. Scenario Building

A scenario is the description of a future situation together with the sequence of events leading from the base situation to the future situation. It tries to conceive the possible future and to explore ways and means to achieve the same, unfolding the present actions and their possible consequences.

5.4.11. Policy Formulation

In a large system, different options relate to different objectives. Thus, there are various diversified policy options associated with various experts which have to be unified to evolve an integrated policy. The option field / profile methodology, introduced by Warfield, is generally used for policy design.

5.4.12. System Dynamics Approach

System dynamics is a conceptual approach that enables to represent the structure and behavior of complex systems over time, providing a method for systems description as well as a useful computational support for simulation (Sterman 2000). The dynamic models thus constructed play a key role for testing the values obtained with the parameterization and comparing them with real data.

SECTION 6

6. OVERVIEW OF PROPOSED RESEARCH

6.1. Need of Study

Cloud computing has recently emerged as a new paradigm for hosting and delivering services over the net. Cloud computing is attractive for business owners because it eliminates the need for users to set up ahead for provisioning, and permits enterprises to begin from the little and increase resources only when an increase in demand.

However, despite the actual fact that cloud computing offers vast opportunities to the IT business, the event of cloud computing technology is presently at its infancy, with several problems still to be addressed. If cloud computing is to realize its potential, there has to be a transparent understanding of the varied problems concerned, each from the views of the suppliers and therefore the shoppers of the technology. There is associated equally pressing want for understanding the business-related problems regarding implementation of cloud computing.

The aim of the research is to interview experts who are either concerned as developers or evaluating cloud computing as associate enterprise user, to spot the strengths, weaknesses, opportunities and threats for the business, the varied problems that may have an effect on the various stakeholders of cloud computing, key problems facing governmental companies who are

concerned within the regulation of cloud computing and set of recommendations for the practitioners who can offer and manage this technology.

6.2. Objectives of the Study

In view of the discussion presented in the previous sections, the present research is aimed at accomplishing the following objectives:

Objective 1: To propose a conceptual framework for cloud computing implementation.

Objective 2: To identify integrated elements for implementation of Cloud Computing.

Objective 3: To develop a hierarchical structural model under relevant contextual relations of the identified elements.

Objective 4: To determine the optimal strategy and action plan for the highest possible level of satisfaction of the stake holders through cloud computing implementation.

6.3. Research Design, Tools and Methodology

The proposed research study will be conducted in the following phases:

Phase 1 - Identifying Integrated Elements for Cloud Computing Implementation

In this phase, the researcher will attempt to identify the relevant factors affecting cloud computing integration. This will be done in an integrated fashion with various interviews at local, regional, national. The researcher will use the system-theoretic tools like Creative Idea Engineering, Brain Writing, Future Projections, etc.

Phase 2 - Development of Hierarchical Structural Model

In Phase 2, the researcher will attempt to develop a hierarchical structural model under relevant contextual relations of the elements identified in Phase 1. Depending upon the nature of identified elements, this may be extended for different contextual relations. The technique of Interpretive Structural Modeling (ISM) would be used in this phase. This phase would require active interactive sessions with the domain experts.

Phase 3 - Finding Optimal Strategy

This phase would involve determination of the optimal strategy and its associated action plan for possible highest level of satisfaction of various stake holders. The technique of fuzzy satisfaction criterion for different strategies may be used for such decisions.

Phase 4 – Developing Dynamic Optimal Strategy

In this phase, the researcher would identify and short-list those elements which have time-based implications. These will then be classified as belonging to stock, flow or auxiliary variables categories. A causal loop diagram would be developed on the basis of the discussion or

workshop session with domain experts. The technique of system dynamics would then be used to conduct simulation analysis in order to come up with a time-based optimal policy.

In addition to the above, the researcher may explore the use of related techniques like Analytic Hierarchy Process (AHP), Artificial Neural Networks (ANN), Pareto's Criticality Analysis, etc.

6.4. Sampling Plan

In the above phases, various set of respondents would be contacted for data collection. These can be classified as policy makers from the government, domain experts from academia and business, and users. The number of respondents in each category in various workshops may vary from 10 to 20. The sampling technique to be used would be non-probability Judgment Sampling.

6.4.1. Brief Outline of Proposed Series of Workshops

Workshop I:

Title: Workshop on "Cloud Computing Implementation from Flexible Systems Perspective"
Dates: During June-Dec, 2016
Venue: Dep. of Management, Fac. of Social Sciences, DEI, Agra

Workshop II:

Title: Workshop on "Interpretative Structural Modeling of Cloud Computing in Business Organization"
Dates: During Jan-May, 2017
Venue: Dep. of Management, Fac. of Social Sciences, DEI, Agra

Workshop III:

Title: Workshop on "Application of Option Profile Methodology for Information Technology Policy in Indian Business Context"
Date: During June-Dec, 2017
Venue: Dep. of Management, Fac. of Social Sciences, DEI, Agra

Workshop IV:

Title: "Flexible Systems Approach for Cloud Computing Implementation in Business Organization: Review Workshop"
Dates: During Jan-May, 2018
Venue: Dep. of Management, Fac. of Social Sciences, DEI, Agra

6.4.2. Analysis of Business Model/Case Study Approach

The researcher may incorporate case studies, wherever applicable, as validation tools to support the claim of the reports and its finding. Application, reports and/or reported business model would also be explored as data source.

Section 7

7. Chapterization

The thesis will contain the following chapters:

Chapter 1 – Introduction

Chapter 2 – Review of Literature

Chapter 3 –Conceptual Framework

Chapter 4 – Research Design and Methodology

Chapter 5 – Data Collection and Analysis

Chapter 6 – Results and Interpretations

Chapter 7 – Conclusions, Managerial Implications and Direction for Future Research

Chapter 8 – Bibliography and References

Section 8

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